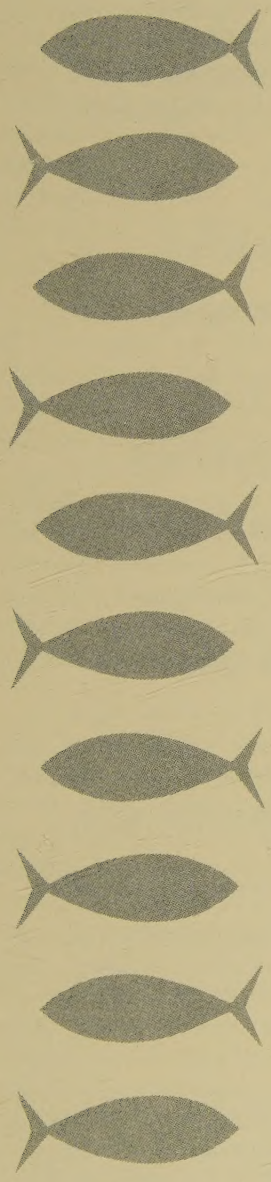
Southwest
FISHERIES SCIENCE CENTER

HONOLULU LA JOLLA MONTEREY TIBURON

REPORT OF ACTIVITIES Third Quarter 1994



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ANTARCTIC ECOSYSTEM RESEARCH GROUP

La Jolla, California

CCAMLR Working Group Meetings

The Scientific Committee (SC) of the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) has established several working groups that meet annually to discuss pertinent CCAMLR issues and to subsequently prepare reports for the use of the SC and ultimately the Commission of CCAMLR. The meetings of the sixth Working Group on Krill (WG-Krill) and the ninth Working Group for the CCAMLR Ecosystem Monitoring Program (WG-CEMP) were held concurrently in Cape Town, South Africa, from July 25 to August 3, 1994. In addition, the second Joint Meeting of WG-Krill and WG-CEMP was held in Cape Town from July 27 to August 2, 1994.

CCAMLR member nations nominate specialists to participate in these working groups. For the United States, Fishery Biologists Rennie Holt and Roger Hewitt (SWFSC) and Eileen Hofmann (Old Dominion University) attended the WG-Krill meeting; Holt, John Bengtson and Peter Boveng (National Marine Mammal Laboratory), Wayne Trivelpiece (Montana State University), and Polly Penhale (National Science Foundation) attended the WG-CEMP meeting. Bengtson, Boveng, Hewitt, Hofmann, Holt, Penhale, and Trivelpiece all attended the Joint Meeting.

A major topic of the working group meetings was the revision of the krill yield model. The same data that were used to construct the original model were again utilized; however, variability in krill recruitment and mortality was more accurately described. The new estimate of yield available for the krill fishery was calculated at 4.1 million tons, an increase from the original estimate of 2.5 million tons. When the original yield estimate was made, the SC followed the WG-Krill's recommendation that a precautionary total allowable catch (TAC) for krill be set at 1.5 million tons. With the new higher yield estimate, some meeting participants argued that the TAC should also be increased. Other participants, however, held the opinion that the 1.5-million-ton TAC should be retained, pointing to the considerable uncertainties associated with the model and the data used to generate it as well as to the low total catch level (82,600 tons) from the krill fishery.

It was decided that, in the future, the WG-Krill and WG-CEMP will be combined into a single working group. The combined working group will be led by one selected convener, and subgroups will be formed during the course of the meeting on an ad hoc basis. The terms of reference for the combined working group were discussed during this year's joint meeting; the final decision for these terms and other goals of the combined group will be decided by the SC and Commission at the upcoming CCAMLR treaty meetings in October.

Prior to this year's working group meetings, a workshop called "Evaluating krill flux factors" was held at the Sea Fisheries Research Institute in Cape Town. The term "krill flux" is used by CCAMLR to describe the immigration and emigration of krill on various fishing grounds and CCAMLR's designated statistical subareas. Previously, the working groups recognized that it is very important to consider aspects of krill flux when calculating estimates of yield for the krill fishery.

During the workshop, a number of small "boxes" were defined within CCAMLR statistical areas based on such criteria as data coverage, natural outlines of oceanographic features, and krill distribution. Krill and water fluxes were calculated for the boundaries of these boxes, allowing for an estimation of how long a mass of water stays in the box and how long the krill reside in the box. The results from the workshop tended to show comparable residence times for water and krill over a range of geographic scales, which suggests that krill may behave as passive tracers in the water (that is, not actively maintaining their position by swimming against the current). However, workshop participants noted that care must be taken in interpreting the data as the main water flows may be separated from areas of high krill densities. One workshop participant also noted that not only horizontal but also vertical migration may be an important factor in the movement and density of krill. In conclusion, the workshop participants agreed that serious consideration must be given to krill flux in the development of management procedures for the krill fishery. (J. Rosenberg, [619] 546-5600)

Juvenile Walleye Pollock Studied in Collaborative Research

During September, Fishery Biologist Roger Hewitt, Ocean Acoustics Engineer David Demer, and Biological Technician David Greene participated in a collaborative research cruise aboard the NOAA Ship *Surveyor* with scientists from the Resource Assessment and Conservation Engineering

division (RACE) of the Alaska Fisheries Science Center. Richard Brodeur was the principal investigator for the project, the Fisheries Oceanography Cooperative Investigation, which was carried out in the vicinity of the Pribilof Islands in the Bering Sea.

The study focused on factors that regulate the recruitment of juvenile walleye pollock. The main objective was to elucidate the diel vertical distribution of juvenile pollock in relation to physical conditions such as temperature, density, and light as well as to biotic influences such as prey densities, jellyfish abundance, and predator distribution. Hewitt and Demer conducted acoustic surveys with the Antarctic Ecosystem Research Group's (AERG) Simrad EK500 system to examine the vertical distribution of juvenile pollock and prey. In conjunction with these surveys, Greene and personnel from the RACE division used the MOCNESS (multiple opening/closing net environmental sampling system) and other net systems to collect juvenile pollock, prey items, and potential predators. Several oceanographic fronts in the study area, which form between shelf water and deep water, were described from the temperature and salinity profiles obtained using conductivity-temperature-depth (CTD) deployments. Hewitt reported that the AERG's acoustic system worked well, revealing distinct layers of juvenile pollock on both sides of the oceanographic fronts. (J. Rosenberg, [619] 546-5600)

COASTAL FISHERIES RESOURCES DIVISION

La Jolla, California

Statistical Considerations in Using LIDAR to Detect Fish Schools and Potentially Estimate Biomass

During a recent workshop on Airborne Fishery Technology, participating scientists reviewed existing technology for airborne sensing of epipelagic fish (those inhabiting the part of the ocean into which enough light penetrates for photosynthesis--such as sardine, menhaden, anchovy, mackerel, herring, and capelin). The workshop was held in Boulder, Colorado, from March 22-24 and co-chaired by John Hunter, chief of NMFS' Southwest Fisheries Science Center's Coastal Division, and James Churnside of NOAA's Office of Oceanic and Atmospheric Research. The systems reviewed included the Light Detection and Ranging (LIDAR) system and various passive systems. The participants, including scientists from NOAA, other U.S. and Canadian agencies, and academia as well as industrial technology representatives, agreed that the focus of airborne survey instrument development for fisheries should be on its potential for biomass estimation because this was deemed to have the greatest management and scientific payoff.

During the workshop, Statistician Nancy Lo made a presentation in which she examined various statistical properties of LIDAR to provide direction for the development of survey instrumentation. She investigated (1) the relation between swath width and school detection, (2) the attenuation of school targets and species identification by depth, and (3) the trade-off between swath width and penetration depth of the laser beam.

Lo compared the use of laser swath widths with visual observations from the airplane. Aerial surveys have been shown to be a cost-effective way to collect data for estimating the relative abundance of various surface-schooling fish populations. The results of preliminary analyses are presented below:

(1) The relation between swath width and school detection

Lo used simulations to determine the effect of swath width on detection probabilities. Detection probabilities are difficult to compute because schools of fish and groups of schools are so contagiously (patchily) distributed. In these simulations, the swath width was varied from 0.04 meter (m), about the size of a nonscanning laser beam, to 900 m, a common scanning area width for an observer from the air looking for fish schools.

The simulations indicated that, as expected, the probability of detecting fish schools does not increase linearly with the width of the swath; rather, it is a nonlinear function of swath width, school size, and fish school distribution. The most striking result of the simulation was that increasing the swath width of the hypothetical instrument from a nonscanning mode of less than 1 m in diameter to a broad scanning mode of a 10-m diameter had a negligible effect on school detection. Even increasing the swath to the 900-m width of a visual observer only improved detection by a factor of about two. Due to the vast habitat of pelagic fishes, and aggregation of pelagic fish schools, the key factor in school detection is the chance encounter of the swath with an aggregation of schools. The width of

the path that intersects such an aggregation is of little importance. The swath width only will play an important role where schools are small and less contagious.

(2) The attenuation of school targets and species identification by depth

The attenuation with depth of the airborne sensor signal used in detecting schools was modeled using the exponential function (e^{-zd}). The coefficient was arbitrarily set to $z = 0.05$, giving an attenuation length of 20 m (1/0.05). When $z = 0.05$, the instrument would detect 37 percent of the targets at a 20-m depth.

When using these airborne sensors, detection should also vary with the vertical distribution of the fish in the water column. Lo fit a Weibull model to the cumulative vertical distributions of anchovy, sardine, Pacific mackerel, and hake larvae.

Both the attenuation function and the vertical distribution of each species were then used to compute the proportion of fish schools detectable in the upper d meters. Undetected schools were also considered to be unidentifiable. They were assigned to species on the basis of average vertical distribution for the species. This classification of unidentifiable schools may produce unbiased estimates of biomass, but may also increase the variance of the final estimates of biomass, in particular, when the fraction of unidentifiable schools exceeds 50 percent.

Lo's analysis indicated that the most precise detection estimates are obtained for the most shallow-dwelling mackerel and the worst estimates are for the mesopelagic hake, which dwell mainly below the range of Lo's hypothetical sensor. Although fishery managers may prefer a more precise index of abundance over a very imprecise estimates of biomass derived from laser detection, the analysis also indicates that value is gained by including crude estimates of species identification on targets, despite the loss in precision. Since a biomass estimate (the eventual end-product of this work) is inherently more valuable than an index (relative abundance of each species), including even weakly-classified species has considerable merit.

In this study, Lo assumed that all targets detected were identified. This, of course, was an idealized conceptualization of the detection function for airborne sampling. In the real world, the attenuation lengths that will be used for species identification, biomass, and simple detection probably differ, with the species identity having the shortest and simple detection having the longest attenuation lengths. This study indicates that even weakly-classified species information is valuable and should be incorporated into the overall survey and biomass estimate strategy.

(3) The trade off between swath width and penetration depth of the laser beam

Lo used her model to examine the relative merits of two aspects of survey instrumentation that might be considered as possible trade offs in instrument design—swath width and laser penetration depth. The probability of detection of fish schools (p) was used to measure the effectiveness of swath width, whereas the proportion ($q(d)$) of fish schools of various species detectable in the upper d meter was used to measure the effectiveness of the instrument in terms of the vertical distribution of the fish and catchability. The quantity ($q(d)$) is defined as the product of the attenuation of detection with depth and the proportion of fish schools for one species above depth d. The quantity pq is a measure of the overall effectiveness of any combination of swath width and penetration depth.

The analysis of pq indicates a laser with beam width of only 0.04 m and a fish detection attenuation length of 20 m (z=0.05) is much more effective for detecting sardine and anchovy than a visual observer with a swath width of 900 m and penetration depth of only 4 m. The laser and the visual observer are equally effective for mackerel because of the mackerel's shallow depth distribution (at least in this example). From the standpoint of survey design, the optimal survey would be one in which penetration exceeded maximum species depth by a considerable margin. Thus, in this example, the laser might be preferable to a visual observer. (N. Lo, [619] 546-7123)

MARINE MAMMAL DIVISION

La Jolla, California

Marine Mammal Survey Completed in North Pacific

On August 31, 1994, the NOAA research vessel *Surveyor* entered port in Dutch Harbor, Alaska, after completing a two-part marine mammal survey along the coasts of Oregon and Washington and along the Aleutian Islands. The objectives differed

on each leg, with specific concentrations of effort in two separate geographical areas. The first leg of the survey was focused primarily on collecting underwater acoustic recordings in the presence of large whales off the coasts of Oregon and Washington and on verifying species identification. This project was designed to test the IUSS (U.S. Navy's Integrated Underseas Surveillance Systems) as a tool for investigating the life history and ecology of large whales, including their movements and abundance estimations. The second leg of the survey was designed to conduct a line transect survey of marine mammals in the historical whaling grounds for blue, fin, and humpback whales south of the Aleutian Islands.

This year's survey was a cooperative effort between the Southwest Fisheries Science Center (SWFSC), the National Marine Mammal Laboratory (NMML), the U.S. Navy, the Pacific Marine Environmental Laboratory (PMEL), the Scripps Institution of Oceanography, Oregon State University, and the University of Washington.

1994 Marine Mammal Survey Overview—In 1991, the Navy began to make available acoustic signal data emitted by whales in the temperate North Pacific Ocean. The data were collected from selected bottom-mounted fixed hydrophone arrays operated by the Navy's IUSS and were made available through PMEL at Newport, Oregon. To date, six call types have been recognized that provisionally match six species of whales from between 400,000 and 500,000 calls per year, some from distances of over 600 kilometers.

This survey was designed to verify the true species identity of the calls using the sighting data collected aboard the *Surveyor* in conjunction with the recordings obtained from the array system. The primary objective was to collect recordings made in the presence of known species of whales. Preliminary studies carried out during last year's Population of *Delphinus* Stocks 1993 survey indicated the potential for utilizing this technique as an assessment tool. Ideally, verifying that a call belongs to a specific species will allow researchers to further explore techniques for estimating whale abundance and identify patterns of distribution by utilizing passive acoustic signals.

The primary objectives of Leg I of the survey were met by maintaining ship contact with land-based monitoring stations for cetacean acoustic indications. The PMEL facility in Newport collected acoustic data from the IUSS including information on the approximate positions of large whales in the study area. These data points were then relayed to the scientists so that the ship could proceed to these given positions to attempt visual confirmation. Sonobuoys were deployed in these areas and also near other whales encountered in the study area. An auxiliary vessel was launched from the ship for acoustic work to support visual observations of the whales made from the ship. Additionally, the scientific party maintained a visual watch of the surrounding ocean during daylight hours (approximately 6 a.m. to 6 p.m.) using four 25x150 binoculars mounted on the ship's flying bridge. The binoculars were mounted on pedestals at a height of 35 feet above the water, giving a maximum ship-to-horizon sighting distance of approximately 6 nautical miles. The ship also conducted line transect surveys as described below when the data transmissions from PMEL were minimal. A final report for this cooperative effort will be completed by the end of November 1994 by Marilyn Dahlheim of the National Marine Mammal Laboratory, Seattle, Washington. (M. Dahlheim, [202] 526-4020)

The primary objectives of Leg II of the survey were also met. This leg concentrated on the line-transect survey of the regions of the North Pacific, specifically the historic whaling regions south of the Aleutian Islands chain. All tracklines were covered as well as all the area making up the historic whaling region. Details of the line-transect survey follows. (R. Brownell, [619] 546-7165)

Line-Transect Marine Mammal Sightings Data Collection—Marine mammal survey work was conducted by marine mammal observers who rotated 30-minute intervals among positions at the port and starboard binoculars as data recorder, independent observer (IO), and IO referee. At least one identification specialist was on watch at all times. The observer at the port binoculars was responsible for surveying the area between 10° right and 90° left of the trackline. The observer at the starboard binoculars was responsible for the area between 10° left and 90° right of the trackline. The recorder searched by eye and with 7X binoculars the full 180° area forward of the ship and recorded sightings and weather information on the computer.

An event-driven data acquisition system (CRUISE2) was employed to record all environmental parameters and sighting information. The system was comprised of a Toshiba laptop computer linked to the vessel's global positioning system (GPS).

The IO "guarded" the 180° area forward of the ship to detect any marine mammals missed by the primary observers. The IO used a pair of 7X or 20X

hand-held binoculars or the naked eye for observations and made the observations from one deck below the flying bridge. If the ship passed the animals without the primary observer making a sighting, only then would the IO call out the sighting. School size estimates of the independent observers were also added to the data acquisition system database. The IO referee would alert the primary observers of an IO sighting once the animals passed the ship's beam and also determined which observer party actually made the sighting if there was any discrepancy.

The IO and the IO referee were included in the rotation of the survey team to obtain an independent estimate of the actual number of animals on the trackline that were missed by the primary observers. This information is crucial to line transect estimation methodology.

The survey area for Leg I extended along the west coast of Oregon and Washington and was bounded by the points 47.20° N, 124.80° W; 47.20° N, 131.20° W; 44.00° N, 131.20° W; and 44.00° N, 124.80° W, and covered approximately 1,500 nautical miles. Leg I was conducted from July 21 through August 1, 1994. Exceptionally good weather prevailed during this part of the survey, resulting in zero days lost to bad weather. Table 1 is a list of the preliminary sightings data of species encountered during both legs of the survey.

The survey area for Leg II was along the Aleutian Islands in the North Pacific Ocean, from Kodiak Island to Tanaga Island. The study area was completely bounded by the points 58.00° N, 152.00° W; 54.50° N, 152.00° W; 49.00° N, 169.00° W; 49.00° N, 178.00° W; 52.00° N, 178.00° W; 58.00° N, 159.00° W; and 58.00° N, 152.00° W. This part of the survey covered approximately 2,050 nautical miles of transect lines and was conducted from August 6 through August 31, 1994. Bad weather during this leg of the survey was a persistent problem, as was expected for this region, but the majority of the planned tracklines were completed, resulting in 116 whale, 227 Dall's porpoise, and 30 pinniped sightings. Humpback whales were the most common whale species, with killer whales, sperm whales, fin whales, and minke whales sighted on a number of occasions (Table 1). The blue whale was not observed in the study area during the survey. (K. Forney, [619] 546-7171)

Table 1. Preliminary marine mammal sightings (number of individuals) collected during the 1994 marine mammal survey from the NOAA research vessel *Surveyor*.

Species	Leg I	Leg II	Total
Risso's dolphin, *Grampus griseus*	3	0	3
Pacific white-sided dolphin, *Lagenorhynchus obliquidens*	6	2	8
Northern right whale dolphin, *Lissodelphis borealis*	5	0	5
Short-finned pilot whale, *Globicephala macrorhynchus*	1	0	1
Dall's porpoise, *Phocoenoides dalli*	63	227	290
Killer whale, *Orcinus orca*	2	21	23
Ziphiid whale	14	0	14
Mesoplodon spp.	4	0	4
Hubbs beaked whale, *M. carlhubbsi*	2	0	2
Cuvier's beaked whale, *Ziphius cavirostris*	7	1	8
Baird's beaked whale, *Berardius bairdii*	3	1	4
Sperm whale, *Physeter macrocephalus*	12	13	25
Balaenoptera spp.	2	3	5
Minke whale, *B. acutorostrata*	0	5	5
Fin whale, *B. physalus*	6	5	11
Humpback whale, *Megaptera novaeangliae*	5	58	63
Unidentified dolphin	0	2	2
Unidentified large whale	0	9	9
Pinniped	0	30	30
Total	135	377	512

Acoustic Data Collected—This year's acoustic research focused on whether the IUSS acoustic detection of marine mammals can be correlated with simultaneous visual and acoustic observations from the *Surveyor*. Sonobuoys were deployed from the ship when marine mammals were sighted to obtain recordings of their vocalizations. These recordings will be used to verify the actual sounds produced by individual species. Low frequency sonobuoys were supplied by Navy Research and Development, San Diego, specifically for these large whale recordings. Sixty-one recordings were made of which 44 were successful in capturing whale vocalization. Eleven species were recorded overall. Seventeen acoustic watches were conducted without any cetacean vocalizations recorded. The number of deployments made during the survey is listed in Table 2. (R. Brownell, [619] 546-7165)

Photographic Identification Techniques Used to Identify Individuals—Individual whales can be recognized from photographs of dorsal fins, tail flukes, and body color patterns. Therefore, photographs from this cruise will contribute to the growing catalog of individually known humpback whales along the Pacific coast. This photographic method provides a detailed, noninvasive examination leading to calculation of vital population parameters such as survival rates, reproductive rates, calving intervals, and age at first reproduction. This technique has proven to be a versatile and powerful technique for addressing a wide variety of management-related issues such as movement, stock identity, and abundance. Photographs taken were obtained from the killer whale,*Orcinus orca*; the fin whale, *Balaenoptera physalus*; the humpback whale, *Megaptera novaeangliae*; Baird's beaked whale, *Berardius bairdii*; and the Pacific white-sided dolphin, *Lagenorhynchus obliquidens*. This year's effort, in conjunction with the ship survey, the acoustic analyses, the habitat studies, and the genetic inquiries will assist managers in making their assessments of large whales off the Pacific coast of the United States. (T. Gerrodette, [619] 546-7131)

Marine Mammal Ecology Studied—Specific oceanographic data designed to provide information on the habitat of marine mammals in the Aleutian Islands were collected during Leg II of the survey. A hull-mounted thermosalinograph was used to collect continuous data on temperature and salinity of surface water. A vertical conductivity-temperature-density (CTD) station was occupied each day 2 hours prior to sunrise. A 12-bottle CTD rosette was used to collect conductivity (salinity), temperature, chlorophyll, C-14 uptake (primary productivity), and nutrient sample data at specific depth intervals at each CTD station. Expendable bathythermograph (XBT) casts were conducted at 9 a.m., 12 p.m., 3 p.m., and 6 p.m. each day. The position and time of each cast was recorded on NOAA XBT and project logs. Surface temperatures were recorded at the times of the XBT casts. At the completion of each day's survey effort, a CTD profile was conducted. Immediately after, an oblique tow with an Isaacs-Kidd midwater trawl was con-

Table 2. Whale vocalizations and recordings collected using sonobuoys deployed during the 1994 marine mammal survey.

Species	Leg I	Leg II	Total
Fin whale, *Balaenoptera physalus*	11	10	21
Humpback whale, *Megaptera novaeangliae*	2	7	9
Baird's beaked whale, *Berardius bairdii*	2	1	3
Sperm whale, *Physeter macrocephalus*	2	0	2
Hubbs beaked whale, *Mesoplodon carlhubbsi*	2	0	2
Killer whale, *Orcinus orca*	1	1	2
Cuvier's beaked whale, *Ziphius cavirostris*	1	0	1
Grey whale, *Grampus griseus*	1	0	1
Minke whale, *Balaenoptera acutorostrata*	0	1	1
Dall's porpoise, *Phocoenoides dalli*	0	1	1
Unidentified whale	0	1	1
Acoustic watches	0	17	17
Total Recordings	22	39	61

Table 3. Summary of oceanographic data collections made during Leg II of the 1994 marine mammal survey.

Type of Sample	Number
CTD casts w/rosette	52
XBTs - successful	66
CTD chlorophyll	221
Surface chlorophyll	170
C-14 primary productivity	154
Nutrient	237
Isaacs-Kidd net tow	22

ducted. The environmental data collected during the survey are summarized in Table 3. (P. Fiedler, [619] 546-7016)

Seabird Observations Conducted—Visual censuses of seabirds were conducted concurrently with the marine mammal observations from the flying bridge of the vessel on Leg II. During Leg I, additional assistance was required to locate whales; therefore, the formal bird survey was not possible since the bird observers were needed as marine mammal observers on that leg. Three seabird observers rotated throughout 2-hour watches to count and identify seabirds viewed in a 90° arc from the bow to either the vessel's port or starboard beam. Approximately 37 different species of seabirds were sighted during the entire survey, comprising an estimated 17,074 birds. Several unusual sightings were made, including nine Short-tailed Albatross and a Dark-rumped Petrel. (R. Pitman and L. Ballance, [619] 546-7148)

Biopsy Tissue Samples Collected for Genetic Analyses—Southwest Fisheries Science Center scientists also collected skin biopsy samples to aid in defining the structure and boundaries of cetacean stocks. Small boats were used to position scientific personnel near the animals. A low-powered crossbow was used to fire arrows with specially designed tips to collect the tissue samples. Samples were taken from 10 humpback whales during Leg II. Some samples were collected from individuals which were also photographed for identification studies. The genetic analyses will be correlated to the photographs taken of the sampled whales.

The tissues will be analyzed for genetic differences using a standard, well-established DNA procedure. Briefly, the procedure first involves extraction of the total cell component of DNA (nuclear and extra-nuclear) from the tissue. The DNA segment desired for analyses (approximately 500 base pairs) is isolated and amplified to high concentrations using the polymerase chain reaction (PCR). The amplified segment is analyzed to determine the sequence of the nucleotide bases (abbreviated A,C,G, or T) that constitutes the genetic signature of the particular animal. The animal's sequences are then analyzed using computer programs that determine the degree of relatedness between individuals. Besides revealing existence of reproductively isolated populations (stocks) and evolutionary lineages, recently developed methodologies allow estimation of gene flow between lineages and average dispersal distances per generation. (R. Pitman, [619] 546-7148 and A. Dizon, [619] 546-7089)

Future Studies Based on PODS93 and *Surveyor* Surveys—From the PODS93 survey and this year's *Surveyor* survey, there is some indication that some species of whales and possibly some individual whales can be detected and tracked from fixed acoustic arrays. Further studies will focus on determining the accuracy of species identifications and vocalization positions extracted from the IUSS data. In addition, data will be collected to estimate the proportion of calling blue whales that go undetected and what proportion of the whales are not vocalizing. Calls from known species will be recorded at close range to provide signal strength and clean vocalization data for refining mathematical models and modeling oceanographic impacts on transmission of these sounds. Data taken from the same whale over several hours/days will be used to examine the variability in acoustic data from a single source.

Future experiments will be conducted jointly by scientists from the SWFSC, NMML, PMEL, and the U.S. Navy. IUSS data from at least four fixed arrays located off the Pacific coast will be monitored at the PMEL's Newport field station. Positions of calling whales will be passed to a NOAA aerial survey team using a NOAA twin otter aircraft equipped with sonobuoys and acoustic recording equipment that will allow the recording of calls and localization of sound sources from arrays of sonobuoys. In addition, the aircraft will be outfitted with high resolution cameras (with forward image motion compensation) that will provide images for species and individual identification. While vectoring to sources of vocalizations that are detected from the IUSS data, the aerial survey team will search for and record sounds from large cetaceans that have not been detected using the IUSS methodology. These data will be used to estimate the proportion of blue whales that go undetected because they are not vocalizing or their calls are not heard. (W. Perryman, [619] 546-7014 and H. Braham, [206] 526-6308)

HONOLULU LABORATORY

Honolulu, Hawaii

PROTECTED SPECIES INVESTIGATION

Adult Male Hawaiian Monk Seals Removed from Laysan Island

Mobbing-related mortality of Hawaiian monk seals, *Monachus schauinslandi*, has been documented at Laysan Island since close observation of that population began in 1977. Mobbing occurs when multiple males gather and, at the same time, attempt to mount the same seal, which may be an adult female or immature seal of either sex. The mobbed seal is frequently injured or killed; the loss of female seals, particularly young adults, is a major impediment to recovery of this important reproductive population. In 1987, the Honolulu Laboratory conducted a workshop to develop a research plan addressing this problem (SWFC Admin. Rep. H-87-12). The goal of the plan was to remove from the population those males having the highest potential of being "mobbers."

Initial research focused on efforts to identify males likely to participate in mobbing so that they could be selectively removed. Careful selection was considered critical because male Hawaiian monk seals appear to form reproductive dominance hierarchies, and dominant males may afford some protection to females in estrus. Inadvertent removal of dominant males could severely disrupt the hierarchy and possibly result in more mobbings. Because Hawaiian monk seals mate in the water, and mating is rarely observed, dominant males are difficult to identify. However, extensive behavioral data collected at Laysan Island from 1983 to 1994 provided a means for estimating relative rank of males in the hierarchy. Males were ranked by the number of associations with prime females (females most likely to be in estrus), and additional analyses of male behavior were used to corroborate the ranking. Assuming that dominant males were correctly identified, selection of other males for removal proceeded. The selection criteria were (1) dominant males could not be removed, (2) males seen in one or more mobbings were removed with highest priority, and (3) other subordinate males were selected only after all known mobbers had been removed. Dominant males were not removed because they may protect females by warding off excess subordinate males.

The Laysan male collection and relocation project was conducted in late July and early August with the goal of removing enough males to reduce the adult sex ratio (male:female) from 1.35:1 (based on 1993 population data) to 1:1. Twenty-two males were captured for relocation (one of these males died immediately after capture). The males were held for 3-14 days at the island in a large fenced enclosure, then caged and loaded on board the NOAA ship *Townsend Cromwell* and transported to release sites around the main Hawaiian Islands. Release sites were chosen to (1) move the seals as far as possible from Laysan Island and (2) distribute them as widely as possible to preclude group attacks on female seals and reduce fishery interaction problems in the main islands. Therefore, seals were released from Kauai to the Island of Hawaii, with a strong bias to the south—over half the seals were released near Maui and Hawaii. All released males were flipper-tagged, injected with at least one passively integrated transponder (PIT) tag, and bleach-marked. Five seals (one released at each of the main islands) also had a satellite transmitter attached to an ankle, which should enable the ARGOS system to track the seals for approximately 1 year and thereby determine if they return to the northwestern breeding islands.

Close monitoring of the Laysan population will continue during the next few years to track the incidence of mobbing and assess the effect of removing these males. The monk seal population at Lisianski Island also has a skewed adult sex ratio and suffers female losses due to mobbing. A clear recovery of the Laysan population following the male removals would indicate that similar action is appropriate at Lisianski. (W. Gilmartin, [808] 943-1239)

PELAGIC RESOURCES INVESTIGATION

Teachers and Students Participate in Longline Research Cruise

Participants in NOAA's "Teacher at Sea" program and students and researchers from the University of Hawaii were hosted by the Honolulu Laboratory and the NOAA ship *Townsend Cromwell* on this summer's pelagic longline research cruise TC-94-05. The teachers, students, and cooperating scientists were involved in all phases of the cruise. For some, this was their first at-sea experience, but all were quickly acclimated and became a functional research team. Everyone worked well together and experienced long hours and hard work, including bait and catch processing, data logging, and com-

puter data processing. The success of the cruise was due in large part to the full participation of the teachers and students.

Daily cruise activities began at 5:30 a.m. with the setting of longline gear with attached time-depth recording devices (TDRs), followed by a conductivity-temperature-depth cast. Fishing gear damaged or lost the previous day was then repaired or replaced. At 2:30 p.m., the fishing gear was retrieved. Generally, live fish were either tagged and released or placed in the baitwell for further study at the Kewalo Research Facility or for live exhibits at the Waikiki Aquarium. Tagged billfish were also injected with tetracycline to determine age from fish otoliths upon recapture. Gear position and morphological data from the catch were recorded, along with times of capture indicated by hook timers triggered when fish bit the hooks. Samples of parasites, muscle, gonad, and stomach contents were labeled and preserved. At the end of the day, TDRs were downloaded on computer, and preparations were made for the next day of fishing. The day usually ended at 9:00 p.m. or later.

During breaks in this busy schedule, the teachers and students learned about the operation and functions of the ship from its officers and staff and participated in discussions about research objectives of the cruise with scientific personnel. Teachers and students gained new experiences as well as an awareness of life aboard ship which they will share back home. They were exposed to a window of marine science far removed from the classroom and helped the Waikiki Aquarium acquire a rare pelagic sting ray for an attractive display specimen in the aquarium's new pelagic exhibit.

The experiences of Kathleen Heidenreich, a teacher from Lacey, Washington, who participated on a *Townsend Cromwell* longline cruise in 1993, have recently been published in *Currents: The Journal of Marine Education* (Vol. 12, No. 3, p. 26-32).

The teachers, students, and cooperating scientists participating in TC-94-05 were as follows:

Teachers

Sue Brooks, Lynden Middle School, Bellingham, Washington

Ardi Kvevin, Snohomish High School, Sultan, Washington

William Mahn, Marist High School, American Samoa

Patricia Mann, St. Joseph's Elementary School, Springfield, Missouri

Peggy Marconi, Oakridge Junior Senior High, Oakridge, Oregon

Students

Kurt Gunderson, University of Hawaii, Honolulu, Hawaii

Douglas Henion, University of Hawaii, Hilo, Hawaii

Tammy Wenham, University of Hawaii, Hilo

Cooperating Scientists

Daniel Curran, University of Hawaii, Joint Institute for Marine and Atmospheric Research, Honolulu

Thomas Fenske, University of Hawaii, Waikiki Aquarium, Honolulu

(R. Chang, (808) 592-8301)

INSULAR RESOURCES INVESTIGATION

Lobster Fishery Closes After Short Season

Previous research by investigators at the Honolulu Laboratory documented a decrease in lobster recruitment in the Northwestern Hawaiian Islands (NWHI) which is correlated with system-wide changes in productivity in the tropical North Pacific. The reduction in lobster recruitment and low catch-per-unit effort (CPUE) values in 1992 indicated that the lobster fishery should remain closed through the 1993 lobster fishing season. To provide a preseason estimate of the 1994 commercial lobster fishery CPUE and quota, all available commercial data from 1983 through 1992 were used in a dynamic production model to simulate the effect of the 1993 closure on the lobster population and to estimate a CPUE value for the start of the 1994 fishing season. Based on the model estimate of July 1994 CPUE, the preseason quota forecast was 200,000 lobsters (spiny lobster, *Panulirus marginatus*, and slipper lobster, *Scyllarides squamosus*, combined).

In May 1994 the annual lobster assessment cruise to the NWHI found CPUE values based on fishing conducted at Necker Island and Maro Reef to be very near those predicted by the dynamic production model (Fig. 1). However, when the commercial fishery opened in July 1994, CPUE values from the first month of fishing were below the model forecast CPUE and also fell below the Fishery Management

Plan (FMP) target CPUE level (Fig. 1). The commercial CPUE values from the month of July were used in the FMP quota formula, resulting in a final quota of 21,000 lobsters, and the fishery was closed after an 8-week season. (W. Haight, [808] 943-1236)

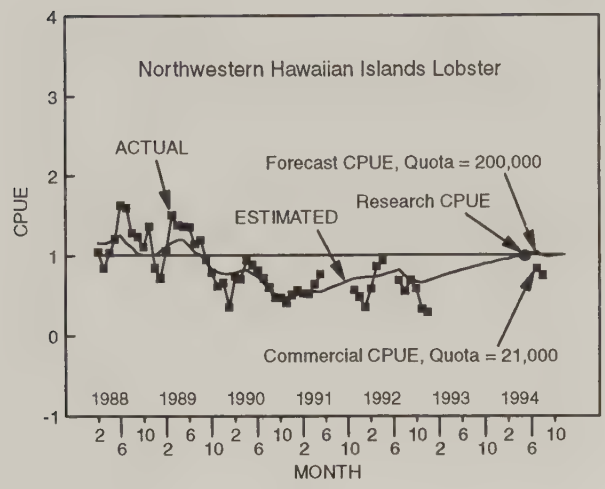

Figure 1. Monthly catch-per-unit-effort (CPUE) and fit of the dynamic production model for the Northwestern Hawaiian Islands commercial lobster fishery. The line running through the data points indicates the model-based estimate of CPUE. The line at the CPUE = 1.0 level is the target CPUE level mandated by the Fishery Management Plan.

PACIFIC FISHERIES ENVIRONMENTAL GROUP

Monterey, California

International Meeting Hosted on Effects of Climate Change on Fisheries in Upwelling Ecosystems

Pelagic fisheries comprise about half the world's marine fish catch yet are subject to major fluctuations with changing environmental conditions, often with far-reaching economic effects. The fluctuations are most dramatic and well documented in upwelling ecosystems such as those off California, Peru and Chile, South Africa, and northwest Africa (Fig. 1). How global climate change will affect these ecosystems and their fishery resources was the subject of the First International Climate and Eastern Ocean Systems (CEOS) meeting in Monterey, California, September 6-8, 1994. The general

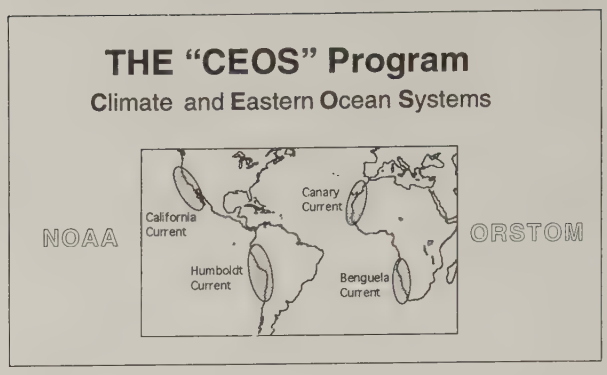

Figure 1. Upwelling ecosystems which are subject to major fluctuations with changing environmental conditions. Shown are systems off California, Peru and Chile, South Africa, and northwest Africa.

theme of the meeting was global versus local changes in upwelling ecosystems. The meeting was convened by Roy Mendelssohn, operations research analyst at Pacific Fisheries Environmental Group (PFEG) and his colleagues Philippe Cury and Claude Roy, who recently completed long-term visits at PFEG from the French research organization Office de la Recherche Scientifique et Technique Outre-Mer (ORSTOM). The meeting was attended by over 40 scientists from more than 15 countries, including the United States, France, Spain, Bulgaria, Morocco, Senegal, the Ivory Coast, Ghana, South Africa, Peru, Chile, Venezuela, and Mexico, with principal funding by the NOAA Office of Global Programs and ORSTOM.

Eastern ocean upwelling ecosystems present certain advantages that may make the study of climate change effects on marine ecosystems particularly tractable. These include the similarity of the major fish species, trophic structures and dynamics, the major ocean processes affecting these ecosystems, and the many years of data available. Scientific results presented at the meeting showed many shared characteristics among these ecosystems, particularly the importance of optimal environmental windows when survival of the young of pelagic fishes is enhanced. This concept had been developed earlier by Cury and Roy during visits to PFEG.

A major focus of the CEOS program is on small pelagic fishes (for example, anchovy, sardine, and mackerel), which are heavily exploited in these large marine ecosystems and have been exhibiting episodes of collapse and rebound, often in what appears to be synchronicity across ecosystems.

Richard Parrish, fishery biologist at PFEG, described the environmental factors that he considered responsible for the rebound of the Japanese sardine which led to its becoming the second largest fishery in the world during the years 1986-91. He suggested that the lack of population rebound for the California sardine at the same time may have been related to an absence of appropriate environmental conditions on the eastern side of the Pacific.

Forty talks were presented at the meeting, under the categories (1) global and local environmental change, (2) pelagic fish and environmental change, and (3) human activities facing short- and long-term change. Scientists did not show obvious signs of climate change caused by anthropogenic, or man-induced factors, but rather, evidence of regular environmental changes on the time scale of decades was highlighted.

The upwelling regions of the world contain marine resources vital to many nations, and the meeting's results will help us understand how changes in the environment affect these resources and the people who depend on them for income and food. Modelers are developing scenarios for potential consequences of global climate change on upwelling resources and are in early stages of projecting ecological, economic, and social impacts on associated human activities and values. The meeting closed with agreements to publish a book documenting the findings and to continue the cooperative CEOS program; an invitation was extended by Chilean representatives to host the second meeting in 1997. (R. Mendelssohn, [408] 656-3333)

PFEG'S Granite Canyon CTD Unit to Become Part of Navy's REINAS Project

Coastal upwelling is one of the dominant processes controlling the circulation and upper ocean structure along the western continental margins. Upwelling also plays a significant role in determining ecosystem energetics because the process introduces high concentrations of nutrients to the photic zone (that area penetrated by light) and because of its impact on flow patterns that control the dispersal and distribution of marine organisms. To understand the dynamics and variability of coastal ecosystems, which include many species of commercially important fish, scientists must have a clear understanding of the physics that drive coastal upwelling as well as determine its spatial and temporal variability.

The California Department of Fish and Game's Pollution Testing Laboratory at Granite Canyon, located along the Big Sur coast about 15 kilometers south of Monterey, is one of several west coast sites for which the Marine Life Research Group at Scripps Institution of Oceanography, San Diego, California, has assembled long time series of daily temperature and salinity from volunteer observations. These series are used regularly by the Pacific Fisheries Environmental Group (PFEG) and other researchers as a source of environmental information in support of numerous studies. Also, the length of these series makes them strong candidates for analysis of interannual variability, including climate change effects. The Granite Canyon daily temperature series extends back to March 1971; daily salinity measurements began in January 1986. The unique value of the Granite Canyon site is its location on the outer coast. It does not have the local effects seen in data from less-exposed harbor and bay installations. An examination of this data set shows that the Granite Canyon series is one of the best records available of coastal upwelling and relaxation events. Because the timing of upwelling events is highly correlated at most upwelling sites, the Granite Canyon data represent current conditions along a large portion of the California coastal environment, the habitat of numerous important marine species.

An uncertainty about these daily-measured time series is the degree to which higher frequency events, such as tides, bias daily observations. A second potential error is the lack of intercalibration and standardization between stations. Another concern is a lack of continuity of measurements at a site (for example, missing samples on bad weather days, a particular problem at Granite Canyon during winter). Automated measurements are required to resolve these problems.

To provide the research community with high-frequency physical data from the coastal ocean, the Physical Oceanography task of PFEG (Oceanographers David Husby, Jerry Norton, Frank Schwing, and LTJG Heather Parker of the NOAA Corps) has agreed to supply the use of a SeaBird SEACAT conductivity-temperature-depth (CTD) unit to Dan Fernandez and other researchers from the University of California, Santa Cruz (UCSC), for deployment at Granite Canyon. In addition to conductivity, temperature, and pressure sensors, the CTD unit includes electronics which allow for future inclusion of photosynthetically available radiance and fluorescence sensors. The CTD will be integrated into the Office of Naval Research-sponsored REINAS (Real-time Environmental Informa-

tion Network and Analysis System) project, which seeks to develop a system for real-time and retrospective regional-scale atmospheric and oceanic monitoring and forecasting using modern communication links such as the Internet. REINAS currently operates an automated meteorological station at Granite Canyon. The data streams from field instruments are linked via radio to UCSC, then to a server for Internet access. Other data available through the REINAS system include wind and air temperature from several land and ocean locations and surface currents from the Monterey Bay region.

The primary rationale for maintaining a CTD unit at Granite Canyon is to support several ongoing science programs sponsored by SWFSC and other regional research groups. Because the time scales of importance to fisheries research often are relatively short, it is important that scientists have access to high-frequency environmental data, preferably in real-time. As part of the REINAS system, data from the CTD unit, along with several other environmental data sets, can be accessed through Internet in nearly real-time.

PFEG has been maintaining the CTD unit in a sea water tank at the Granite Canyon Lab to test its reliability and for comparison with direct ocean measurements. The unit has been providing quality data for several months (Fig. 2). The time series of temperature and salinity clearly show a daily cycle superimposed on a relaxation event about June 10, and a reduction in upwelling starting in early July. However, the lab environment has not proven to be consistent with ocean conditions, mainly because of daily heating in the lab.

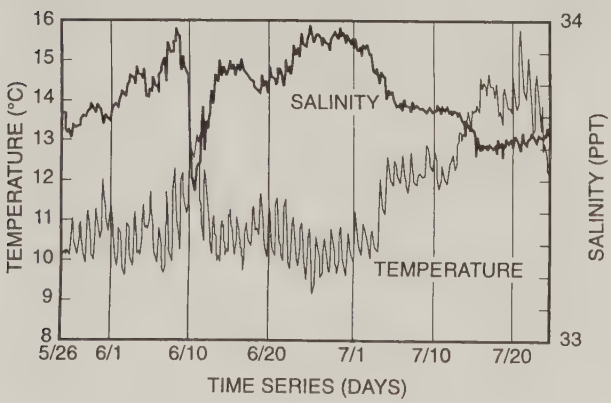

Figure 2. Time series of temperature and salinity taken during May 26-July 27, 1994, in a tank supplied with running sea water at the California Department of Fish and Game's Granite Canyon Lab. Tick mark spacing along horizontal axis is one day. Sampling interval is 10 minutes.

While the exposure of Granite Canyon to the ocean makes it an ideal site for monitoring large-scale ocean variability, these conditions also require instrument installations that minimize vibration and abrasion due to seas that reach 10-20 feet each winter. PFEG and UCSC staff, along with Jim Lytel, the Granite Canyon Lab's maintenance supervisor, have jointly developed plans for the secure installation of the unit in the near-shore ocean, and for data acquisition and storage in the REINAS system. The configuration will allow the CTD to be deployed and recovered without the need of diver support, an important requirement at this rugged site.

The volunteers at Granite Canyon will continue to make daily observations for comparison and quality control of CTD measurements. We are hopeful that this installation will encourage deployment of similar systems at other west coast stations and serve as a prototype for updating existing NOAA National Ocean Service coastal stations. The Granite Canyon unit is a component of the NOAA Coastal Forecast System or Global Ocean Observing System. (J. G. Norton, [408] 656-3294)

Hydrographic Data from Rockfish Surveys Summarized in Technical Memoranda

Researchers at Tiburon Laboratory and the Pacific Fisheries Environmental Group (PFEG) have collaborated on two new NOAA Technical Memoranda that summarize hydrographic conditions during the 1992 and 1993 pelagic young-of-the-year rockfish surveys. Environmental conditions from the coastal ocean bounded by Cypress Pt. (36°35'N) and Bodega Bay, California (38°19'N), and from the coast to approximately 300 kilometers offshore, are summarized in a series of horizontal maps and vertical transects. Sampling in each year included one survey in late February-early March (*David Starr Jordan* cruises DSJ-9203 and DSJ-9304), and three repeated sweeps of the region during May-June (DSJ-9206 and DSJ-9307). Data products contained in the memoranda include (1) a master list of all conductivity-temperature-density stations during each cruise; (2) surface meteorological time series from the region's four National Data Buoy Center meteorological buoys and a coastal station; (3) horizontal maps of temperature, salinity, and density at depths of 2, 10, 30, 100, 200, 300, and 500 m; (4) temperature, salinity and density along five cross-shelf vertical transects; and (5) dynamic height maps at the surface, referenced to 500 m. Acoustic doppler current profiler (ADCP) data acquired by the *David Starr Jordan* during the surveys are currently being processed and will be summarized at a later date.

The most distinctive characteristic of the hydrographic conditions seen during the 1992 and 1993 surveys was the anomalously warm and fresh water found throughout the water column (Fig. 3). Compared to the mean for all May-June sweeps for the period 1987-1992 (n=18), temperatures in 1992 were generally 1-4 °C higher near surface and 0.2-0.9 °C higher at 200 m; salinities were generally 0-0.8 parts per thousand (ppt) lower near surface and 0-0.1 ppt lower at 200 m. This is illustrated in Figure 4 which shows vertical sections of temperature and salinity anomalies for DSJ-9206, sweep 1 off Davenport, California (May 13-14, 1992), relative to 1987-92 (Fig. 4). These anomalies are nearly all one to three standard deviations outside the means. Lightly shaded areas on the standard deviation plots in Figure 4 denote regions anomalous by greater than two standard deviations.

The warm, fresh conditions observed during both years were a continuation of those occurring off central California and the west coast beginning in early 1992, a manifestation of the 1991-93 El Niño/Southern Oscillation (ENSO). A comparison to the California Cooperative Oceanic Fisheries Investigations spring climatology studies suggests the most likely mechanism for explaining the 1992-1993 hydrography is the movement of California Current water toward the coast from the west. A similar onshore transport apparently occurred during the 1940-41 and 1982-83 ENSO events.

In addition to collaborating on the annual surveys and the production of the technical memoranda series, Tiburon and PFEG scientists are

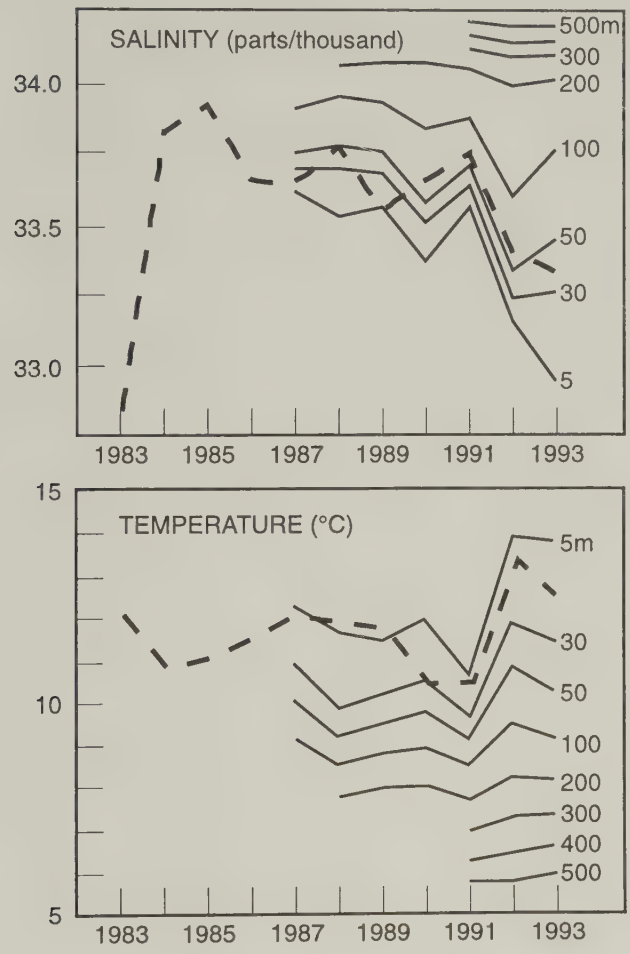

Figure 3. Time series of mean temperature and salinity from May-June rockfish surveys 1987-93, at 5, 30, 50, 100, 200, 300, 400, and 500 m, comparing means from May-June 1987-92 surveys. Means for depths greater than 200 m available from 1991-93 only. Dashed line denotes average of daily measured surface temperatures and salinities for May-June of each year at Farallon Island, for period 1983-93.

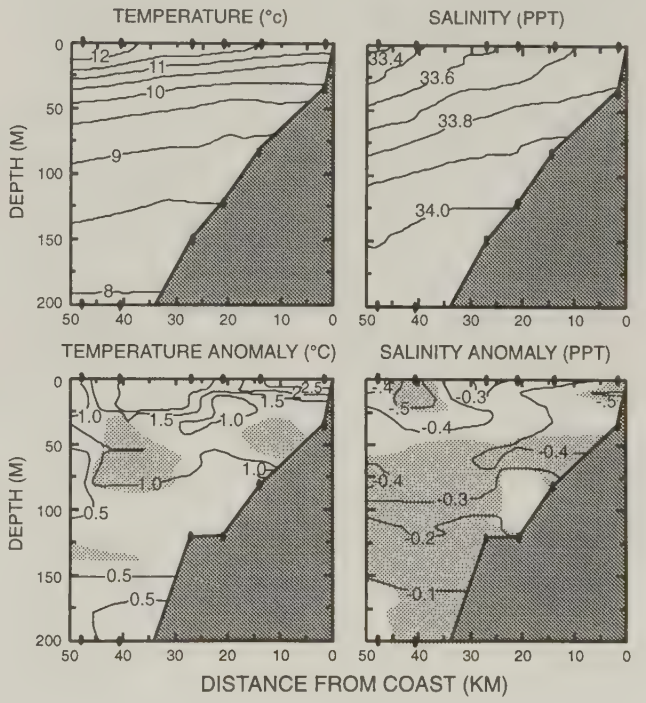

Figure 4. Vertical sections of temperature and salinity off Davenport, California. Upper figures show mean temperature and salinity fields from all May-June sweeps during 1987-92 (n=18). Lower figures show temperature and salinity anomalies during cruise DSJ-9206, sweep 1 (May 13-14, 1992), relative to the 1987-92 means. Lightly shaded areas denote locations where anomalies were greater than two standard deviations from mean. Darkly shaded areas denote sea bottom. PPT = parts per thousand.

working jointly on the analysis of the environmental data. Ultimately, it is their goal to determine and forecast the manner in which rockfish year-class strength is affected by variations in the physical environment. Several manuscripts are in preparation or planned, based on these analyses. (F. B. Schwing, [408] 656-3298)

PELAGIC FISHERIES RESOURCES DIVISION

La Jolla, California

PELAGIC ECOSYSTEM MODEL DEVELOPMENT PROGRAM

Fourth Meeting of the Western Pacific Yellowfin Tuna Research Group (WPYRG) Held

Fishery Biologist Gary Sakagawa, Pierre Kleiber, and Mathematical Statistician Al Coan attended the Fourth Meeting of the Western Pacific Yellowfin Tuna Research Group (WPYRG) held in Koror, Republic of Palau, August 9-11, 1994. Sakagawa chaired this and the two previous meetings of the Group. Participants included representatives from Pacific Rim and Pacific Island countries as well as from two international agencies, the Forum Fisheries Agency (FFA) and the South Pacific Commission (SPC).

The goal of WPYRG has been to assemble scientific information to address three questions related to yellowfin tuna in the western Pacific: (1) What is the safe level of yield and exploitation for the stock? (2) What is the interaction among the different fisheries that harvest the stock? and (3) What factors could contribute to local depletion? WPYRG has collected yellowfin tuna fishery statistics for seven sub-areas within the western Pacific (Fig. 1), and participating scientists have undertaken various projects using those statistics as well as other relevant data to conduct analyses related to the three questions.

The following is a brief account of highlights that were on the agenda of the fourth WPYRG meeting:

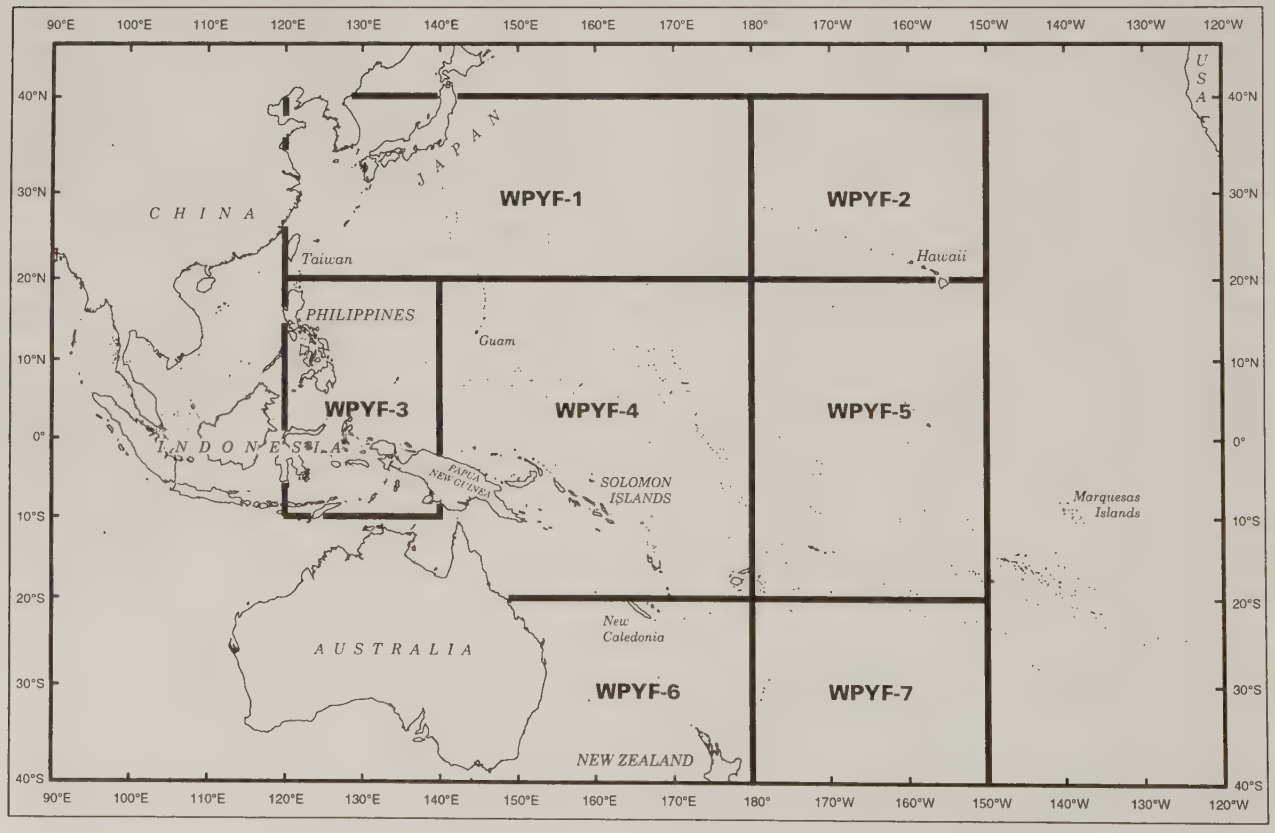

Figure 1. Western Pacific Yellowfin Tuna Research Group (WPYRG) study area and statistical areas for reporting fisheries statistics.

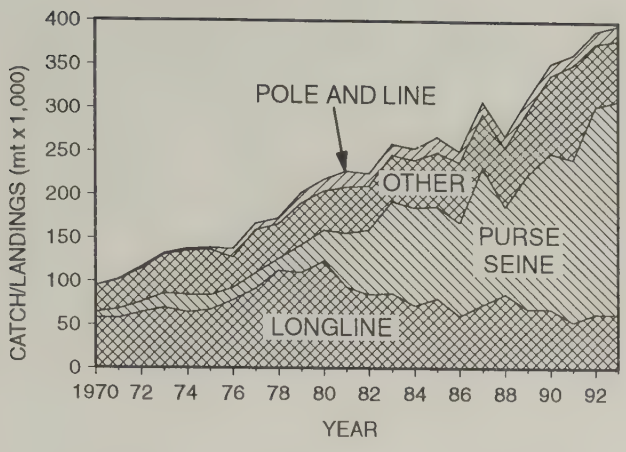

Figure 2. Catch of yellowfin tuna by gear type from the central-western Pacific Ocean, 1970-1993.

Recent developments in the various fisheries harvesting yellowfin tuna in the region were reviewed. Overall, the region's catch of yellowfin tuna in 1993 was 380,000 metric tons (t), a decline of approximately 3 percent from the previous year (Fig. 2). This was largely due to reduced fishing effort by purse seiners, who produce the bulk of the yellowfin tuna catch. The following factors are believed to have contributed to the reduced fishing effort: (1) the implementation of the South Pacific Forum Fisheries Agency policy of limiting the total number of purse seine vessels to 205 and prohibiting at-sea transshipments, (2) protracted negotiations for renewal of access agreements for some fleets, (3) loss of several vessels through sinking, and (4) low prices for tuna destined for canning.

The WPYRG fishery database was updated with contributions from several participants. Collection of complete and accurate statistics continues to be plagued with problems due to the complex mixture of fleets, which all have different characteristics such as range, gear, nationality, and language of operators. However, improvements continue to be made. A significant new development in this respect is the startup expected in 1995 of an at-sea observer and observer training program under the auspices of the SPC Oceanic Fisheries Programme that will augment existing observer programs operated by the FFA and individual island countries.

Results of analyses presented at the meeting included standardized catch-per-unit effort (CPUE) trends for Taiwan and Japanese longline and purse seine fisheries. The general picture shows an increasing trend in standardized purse seine CPUE and a decreasing trend in standardized longline CPUE. Because of difficulties inherent in CPUE data and standardization techniques, the group did not unequivocally accept the results as a reliable picture of trends in yellowfin tuna stocks available to the longline and purse seine fleets or as a definitive indication of interaction between the two gear types. The results, instead, were felt to be reliable indicators of trends in fishery performance.

An updated analysis of the SPC tagging data for yellowfin tuna indicated that the current exploitation rate is approximately 20 percent, which means that the population could very likely sustain an increase as much as twice the current harvest of 380,000 t, for example, without detrimental impact. This result was confirmed by a production model analysis which produced an estimated maximum sustainable yield of 670,000 t. This sanguine picture of the overall stock status is tempered by the possibility that overfishing and local depletion in certain localities could be occurring. To address such subregional questions will require better knowledge of recruitment and movement patterns. Progress was reported on development of an assessment model to deal with such patterns.

The question of purse seine versus longline interaction was evaluated in an analysis of SPC tag data. The results showed that returns of tagged yellowfin tuna from longliners were significantly less than expected given the returns from purse seiners. One interpretation of this is a reduced availability of fish to longliners; however, this interpretation is confounded by other possibilities including lower reporting rate of tag returns by longliners than by purse seiners.

An important item on the meeting agenda was the future of the WPYRG, whose formal mandate was to cease following this meeting. It was unanimously agreed that the WPYRG should continue given that its primary objectives are still largely unfinished. The objectives are to determine the (1) safe level of exploitation for the stock, (2) degree of interaction among fisheries harvesting the stock, and (3) factors that could contribute to local depletion. It was also agreed that a rotating chairmanship would be a good policy; Sachiko Tsuji of the National Research Institute of Far Seas Fisheries (Japan) was elected chairperson of the Group.

A detailed report of the meeting is in preparation. (P. Kleiber, [619] 546-7076)

STOCK ASSESSMENT AND FISHERY IMPACT ANALYSIS PROGRAM

Shark Assessment Planning Workshop Held

A workshop was held at the Southwest Fisheries Science Center (SWFSC), August 30-31, to develop a cooperative scientific program that could provide accurate stock assessment information for pelagic sharks fished along the west coast of the United States and Mexico. The workshop was attended by 20 participants from the Center, California Department of Fish and Game, California State University system, and from the Instituto Nacional de Pesca and Centro de Investigation Cientifica y de Educacion Superior de Ensenada. The workshop was chaired by SWFSC Fishery Biologist Dave Holts. On the first day, the participants reviewed current research being conducted while on the second day, SWFSC Planning Officer Dave Mackett facilitated a planning session, assisted by Computer Specialist Than Vu and Coastal Division Secretary Karen handschuh.

During the workshop, 62 specific research activities, in 12 research categories, were identified by the participants as necessary to perform accurate stock assessments. Three key pelagic sharks (blue, shortfin mako, and common thresher) were identified as requiring immediate research focus. The workshop results are currently being reviewed by the participants and a report will be available in December. (D. Holts, [619] 546-7186)

TIBURON LABORATORY

Tiburon, California

GROUNDFISH COMMUNITIES INVESTIGATION

Lingcod Stock Assessment Completed

A recent examination of lingcod, Ophiodon elongatus, data from commercial sampling initiated in 1992 has pointed to general signs of population decline. This assessment covered the Oregon portion of the Columbia International North Pacific Fisheries Commission (INPFC) area, along with the Eureka, Monterey, and Conception INPFC areas. In the Oregon portion of the Columbia area, landings have decreased dramatically. The lengths of the fish sampled there in 1992 and 1993 peaked at 450 to 550 millimeters (mm) and at the ages of 2, 3, and 4 years old. Lingcod landed in the Coos Bay fishery were even smaller and younger, with over 35 percent of the lingcod being under 450 mm and essentially 1+ years old. Eureka area landings also decreased from a 1981-85 average of 371 metric tons (t) to a 1991-93 average of 181 t. Eureka area length-frequency distributions of trawl-landed lingcod taken in 1992 and 1993 peaked between 450 and 650 mm, which corresponds to 3-, 4-, 5-, and 6-year-old fish. These lengths were smaller than 1978-83 size ranges of between 550 and 750 mm. Monterey commercial landings also decreased from a 1981-1985 average of 698 t to a 1991-93 average of 500 t. Trawl landings decreased dramatically and were compensated by increases in gillnet and hook gear landings. Length compositions of trawl landings peaked at the 450- to 550-mm size range and have decreased about 100 mm from the 1978-83 sampling. In the Conception area, the 1992-1993 size range of the commercial landings also decreased about 100 mm from earlier sampling.

Although the analysis is limited by existence of samples only from 1992 and 1993 along with limited historical data, some conclusions can be drawn. The lingcod landed in the 1992-93 sampling were small and young. Female lingcod that were smaller than the size at which one-half were found to be mature (50 percent size at maturity) made up 63 percent of the females sampled. Also, whenever there were length data available previous to the 1992-93 sampling, average size from these data was substantially larger than in the recent sampling.

The potential effect of lingcod trawl trip limits ranging from 0.45 to 13.61 t (1,000 to 30,000 pounds [lb]) was examined using the 1981-88 PacFIN research database. Trip limits could accomplish sizable reductions in coastwide landings, ranging from 1,335 t for a 0.45-t (1,000 lb) trip limit to 89 t for a 13.61-t (30,000 lb) limit. In the 1981 to 1988 time period, this would result in an average reduction ranging from 48 to 3 percent of total commercial landings. The regional impact of a coastwide trip limit would fall largely on the International Pacific Fisheries Commission Columbia and Vancouver areas, with the degree varying with limit size. For the 13.61-t (1,00 lb) limit, 75 percent of the reduction would come from these two areas. (P. Adams, [415] 435-3149)

GROUNDFISH ANALYSIS INVESTIGATION

Assessments Completed on Two Species of Deepwater Rockfish

Fishery managers and scientists have expressed concern about the status of stocks of deepwater rockfish off California, Oregon, and Washington. Landings of individual rockfish species are relatively low compared to most species that are actively managed by the Pacific Fishery Management Council (PFMC) and NMFS. Relatively little is known about the deepwater rockfish species, except for the Pacific ocean perch *Sebastes alutus*. Estimates of life history parameters are available for only some of the deepwater rockfish. These deepwater rockfish species are very long lived and, thus, probably cannot support high fishing mortality rates. However, some deepwater rockfish species are small, and only relatively large individuals appear to be vulnerable to fishing. The smaller species may be able to support high fishing intensity because only a small portion of their populations are vulnerable to fishing. Pacific ocean perch, once one of the most abundant rockfish species off Washington and Oregon, is known to be depleted and its life history is similar to the other deepwater rockfish species that have been studied. Although the PFMC has severely constrained the fishery for this species since 1979, there has been very little recovery. The most recent assessment indicates that there will be little recovery during the next 20 years unless exploitation is kept at very low levels. There is concern that other deepwater rockfish stocks may be overfished or could become so unless protected.

The Groundfish Management Team (GMT) of the PFMC has begun the process of assessing deepwater rockfish species and exploring harvest policies that may be required to protect them. These species (except Pacific ocean perch) are presently included in the general rockfish complex for management. They would be difficult to manage on an individual basis because they are not subject to large directed fisheries. Thus, both data collection and regulation enforcement would be difficult. Some have proposed that deepwater rockfish species be managed as a group. Studies of survey and fishery observer data from Oregon and Washington indicate that several deepwater rockfish species form an assemblage. The species composition is different off California and observer data are not available for assemblage analysis. While the northwest data indicate that there is a deepwater rockfish assemblage with respect to survey and fishery catches, it is not clear that management by assemblages would protect the individual species from overfishing while allowing catches that the individual species could support. It will be a difficult challenge to develop practical management regimes for these species.

It is also difficult to adequately assess the deepwater rockfish species because needed data are often lacking. However, the assessment process has begun. Descriptions of two preliminary assessments follow. (W. Lenarz, [415] 435-3149, ext. 226)

Bank Rockfish Assessment—A stock assessment on bank rockfish, *S. rufus*, by Fishery Biologist Donald Pearson has been published by the PFMC as Appendix E to its 1994 status of stocks document. Bank rockfish is a slow-growing, long-lived species that reaches sexual maturity at a comparably old age. Fifty percent of female bank rockfish are sexually mature at 16 years of age (35 centimeters fork length). There has been a long-term decrease in the mean length of bank rockfish in the commercial landings which is most likely a result of fishing pressure. Increasingly, the fishery is taking large numbers of small, presumably immature fish. Bank rockfish are often landed with a variety of deepwater species including darkblotched rockfish, *S. crameri*; splitnose rockfish, *S. diploproa*; and blackgill rockfish, *S. melanostomus*. These species have life history characteristics making them unable to support high levels of fishing mortality. It was therefore proposed to include bank rockfish into a deepwater rockfish complex, making it easier to monitor, and if necessary, to restrict the landings. (D. Pearson, [415] 435-3149, ext. 237)

Splitnose Rockfish Assessment—Fishery Biologist Jean Rogers completed an assessment on splitnose rockfish which was also published by the PFMC as an appendix to its 1994 status of stocks document. Trends in the available data did not consistently demonstrate effects from fishing the stock. Possible signs that fishing stocks may have decreased are that large tow catches only occurred in the early years of the triennial surveys; large older females were more prevalent in the 1980 triennial survey versus the smaller females in the following years; and population estimates by the NMFS fall slope surveys showed a decrease in population (although the 90 percent confidence intervals overlapped). Evidence which indicates that the stock has not been affected substantially include the comparatively small physical size of individuals in the 1960 commercial catch, the fairly stable length frequencies in the recent commercial catches, and

the stable triennial and Pacific ocean perch survey biomass estimates. Because the size at 50 percent maturity is less than the size of most of the trawl catch, even when discards were considered, the species may be able to withstand greater fishing pressure than many of the other rockfish species. Splitnose rockfish has been determined to be part of a group of deepwater rockfish commonly caught together off the coasts of Oregon and Washington, and a joint deepwater rockfish stock assessment is planned for 1995. The other species in that assemblage are not abundant off the California coast, and available analyses indicate it may be selectively targeted in that area. (J. Rogers, [415] 435-3149, ext. 225)

GROUNDFISH PHYSIOLOGICAL ECOLOGY INVESTIGATION

Lipid Changes Studied in Ovaries of Shortbelly Rockfish During Embryogenesis

A factor in the survival, and thus year-class strength, of young-of-the-year (YOY) rockfish is their nutritional energy status. Clearly, the ability to persist during the first days to months following parturition depends upon the availability of nutrients for tissue synthesis and energy-requiring processes. The source of these nutrients may be from feeding or from endogenous stores acquired during ovarian development.

Many species of rockfish on the California coast release larvae during January-March, prior to the onset of upwelling and the subsequent surge in primary and secondary productivity. Since larval rockfish feed on zooplankton, their survival, until favorable environmental conditions generate abundant forage, may depend upon endogenous energy reserves.

To determine the relationship of nutritional energy status to growth and survival, analysis of the lipid dynamics in embryo and early life stages of the shortbelly rockfish, *Sebastes jordani*, has been included in a study of physiological development and the influences of environment and maternal contributions to year-class survival. The assessment of maternal contributions focuses primarily on ovarian processes since previous research on yellowtail rockfish, *Sebastes flavidus*, found direct relationships between ovarian lipid variables and reproductive success. The coupling of somatic factors (such as mesenteric fat accumulation, condition indices, tissue protein and lipid concentrations, and serum nutrient dynamics) to the quantity or health of ovarian larvae was obscure.

Rockfish have been shown to be primarily lecithotrophic, that is, embryos obtain most of their nutrition from yolk and oil sequestered in the ovaries prior to fertilization. Consequently, lipid concentrations decline as embryos develop and grow. The amount of lipid remaining when hatched larvae are released into the environment must sustain them until forage levels become favorable. Differences in lipid content of larvae at release are hypothesized to be a contributing factor in variable year-class survival, particularly during those years when upwelling productivity is delayed. Yearly estimates of larval lipid content and lipid class composition at release are included in the database that will be used to determine the relationships of shortbelly rockfish YOY physiological condition to environmental variables and early life stage abundance.

Projection of the preliminary data on the change of total lipid concentration in shortbelly embryos from fertilization to parturition during 1993 indicated larvae retained about 37 milligrams lipid per gram of body weight at spawning (embryonic stage 33, Fig. 1). This represents a 66 percent decline in ovary lipid from fertilization to parturition. These results show shortbelly rockfish utilize a greater proportion of available lipid for embryogenesis than yellowtail rockfish (about 30 percent utilized). Further, shortbelly rockfish larvae contained only about half the lipid of yellowtail rockfish at release, suggesting a more urgent need to obtain food from the environment. (B. MacFarlane, [415] 435-3149, ext. 244)

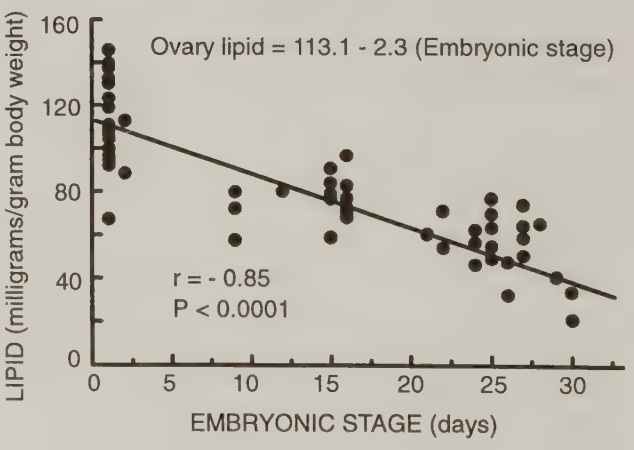

Figure 1. Change in ovary lipid concentration from fertilization to parturition in shortbelly rockfish during 1993 reproductive period (January to March). Embryonic stages (by days): (1) prefertilization, (2) germ disc, (9) morula, (15) embryonic shield, (20 to 27) optic cups to transparent lens, (31) prehatching, and (33) hatched larva.

INFORMATION TECHNOLOGY SERVICES

La Jolla to Connect to NMFS IT-95 Wide Area Network

The implementation of a NMFS Wide Area Network (WAN) is under way. The WAN is intended to interconnect all NMFS sites to provide NMFS-wide network access to the various Information Technology 95 (IT-95) host computer systems being installed under the IT-95 initiative. IT-95 host systems are to be installed nationwide. IT-95 host computer sites at the Southwest Fisheries Science Centers (SWFSC) include the La Jolla Lab, the Honolulu Lab, and the Pacific Fisheries Environmental Group (PFEG) in Monterey.

The NMFS WAN is being installed by AT&T under the mandatory GSA FTS-2000 contract. The WAN is to be made up of dedicated digital data circuits connecting each of the NMFS sites to AT&T's nationwide Frame Relay Network. Frame Relay is a network interface standard developed by the American National Standards Institute (ANSI) and other international standards organizations. The NMFS WAN is organized using the concept of interconnected regional hubs. In the SWFSC, for instance, La Jolla will be a hub, with private virtual circuits going to the Tiburon Lab, the Long Beach Regional Office, and PFEG. These private virtual circuits are to have 32-kilobit-per-second (Kbps) committed information rates running on a 56-Kbps physical connection.

Frame Relay's use of private virtual circuits makes use of "bank-shot" routing schemes to provide site-to-site connectivity. For instance, a telnet session from Tiburon to Miami would use a "bank-shot" route from Tiburon to La Jolla, from La Jolla to Headquarters, then from Headquarters to a Miami router and the Miami host computer. The planned WAN will be managed centrally from the Headquarter's hub, using the Simple Network Management Protocol (SNMP), which provides good coordination and trouble-shooting capabilities which are often a problem over large widely dispersed WANs.

The La Jolla Lab will also be connected to the NMFS Headquarter's hub, which will be the center of the nationwide WAN, using a 128-Kbps committed information rate running on a T-1 physical circuit. T-1 is Bell Telephone terminology referring to a digital carrier facility for the transmission of data. T-1 circuits have a maximum transmission rate of 1.544 megabits per second. The T-1 circuit will connect to a NetBuilder II router via a high-speed serial port. NetBuilder II routers have been chosen as the standard for the NMFS' IT-95 WAN. Other ports on the NetBuilder II will connect to various segments of the Center's Local Area Network (LAN) with one port reserved for a connection to the recently installed Scripps Institute of Oceanography (SIO) fiber optic ring (which is called the Fiber Distributed Data Interface, or FDDI) network. The SIO FDDI is a 100-megabit-per-second network with a 100-megabit-per-second connection to the University of California at San Diego FDDI LAN. The use of the NetBuilder II router to combine the connection of three networks (NMFS IT-95, La Jolla LAN, and SIO FDDI) provides the opportunity for improved control of network traffic on the Center's LAN through better separation of traffic using subnetworks. NetBuilder II access control lists provide the opportunity to increase network security generally by defining allowable and illegal connections from one router port to another. (F. Ralston, [619] 546-7062)

PUBLICATIONS

Published

Balazs, G. H., and S. G. Pooley. 1994. Research plan to assess marine turtle hooking mortality: results of an expert workshop held in Honolulu Hawaii, November 16-18, 1993. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-201, 166 p.

Barlow, J., and T. Lee. 1994. The estimation of perpendicular sighting distance on SWFSC research vessel surveys for cetaceans: 1974 to 1991. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-207, 46 p.

Chivers, S. J., and D. P. DeMaster. 1994. Evaluation of biological indices for three eastern Pacific dolphin species. J. Wildl. Manage. 58(3):470-478.

Potential biological indices of population status (that is, *N* relative to carrying capacity [K]) were tested for three dolphin species in the eastern tropical Pacific between 1974 and 1992. On the basis of a qualitative population response model, the researchers predicted positive correlation with status for the proportion of sexually mature females present in the population and a negative correlation for the proportion of simultaneously pregnant and lactating females. Two popula-

tions were expected to exhibit compensatory responses because their populations were near K in 1974 and subsequently declined. Indeed, population status was correlated ($P < 0.05$) with ≥1 reproductive parameter, as predicted, for the southern portion of the western/southern pantropical spotted dolphin (*Stenella attenuata*) and the central short-beaked common dolphin (*Delphinus delphis*). Correlations ($P < 0.05$) for the northeastern pantropical spotted dolphin also were found, although none were predicted because population status was already reduced to approximately 20 percent of K by 1974. Furthermore, correlations were detected ($P < 0.05$) between life history parameters and year for the eastern spinner dolphin (*S. longirostris orientalis*) and whitebelly spinner dolphin (*S. l. longirostris*) indicating that the populations were responding to changing population density although no change in status was reported. The researchers concluded that regulatory mechanisms are likely to be operating between 20 percent of K and K, and therefore, reproductive parameters can be useful indices to distinguish between changes in population status caused by exploitation or changes in K. However, relationships between the life history parameters and population status must be known. The researchers also presented sample size requirements for detecting changes in the parameters tested for time series of varying lengths.

Everson, A. 1994. Fishery data collection system for fishery utilization study of Kaneohe Bay: two-year interim report. Department of Land and Natural Resources, Division of Aquatic Resources, State of Hawaii. Technical Report 94-01, 45 p.

Fiedler, P. C. 1994. Seasonal and interannual variability of coastal zone color scanner phytoplankton pigments and winds in the eastern tropical Pacific. J. Geophys. Res. 99(C9):18,371-18,384.

Time series of phytoplankton pigment concentration along coastal and oceanic transects in the eastern tropical Pacific Ocean were derived from coastal zone color scanner monthly composite data for November 1978 through June 1986. Seasonal and interannual variability made up about half the total variance of the time series. Seasonal cycles typically consisted of a spring minimum and fall maximum although many local variations were observed. Interannual variability was as great as seasonal variability and was dominated by the 1982-1983 El Niño event. The decline in pigment concentration during 1983 was less to the west of the Galapagos than to the east and along the Central American coast. Physical forcing of pigment variability was investigated by testing correlations between pigment concentration and wind variables associated with upwelling and mixing. Seasonal cycles and some interannual changes in pigment concentration were correlated with local wind-driven processes that cause variation in primary productivity. Correlations between pigments and local winds in oceanic transects were different at seasonal and interannual scales, implying remote forcing at the interannual timescale.

Keen, J. E., K. L. Cousins, A. P. Farrell, R. W. Brill, and K. R. Olson. 1994. Exogenously-applied and endogenously-derived atrial natriuretic peptide in the yellowfin tuna (*Thunnus albacares*): cardiovascular responses, plasma natriuretic peptide concentration and distribution of immunoreactive granules. (Abstr.) Conference proceedings of the American Physiological Society, San Diego, California, October 29-November 2, 1994.

Mitchell P. C., J. L. Megyesi, C. S. Hall, J. L. Glueck, L. P. Laniawe, E. A. Delaney, S. S. Keefer, M. A. McDermond, M. Schulz, G. L. Nakai, B. L. Becker, L. M. Hiruki, and R. J. Morrow. 1994. The Hawaiian monk seal at French Frigate Shoals, 1990-91. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-210, 70 p.

Perrin, W. F., G. D. Schnell, D. J. Hough, J. W. Gilpatrick, Jr., J. V. Kashiwada. 1994. Reexamination of geographic variation in cranial morphology of the pantropical spotted dolphin, *Stenella attenuata*, in the eastern Pacific. Fish. Bull., U.S. 92(2):324-346.

A previous study evaluated morphological variation in skull morphology, but now specimens are available for a greater portion of the range. Also, corrections have been made in data and an assessment has been made evaluating repeatability of character measurements. The researchers reassessed geographic variation in 30 cranial features based on 611 museum specimens. Mantel tests matrix correlations in offshore spotted dolphins, principal components, canonical-variates, and cluster (UPGMA and function-point) analyses were employed to assess geographic variation. In the eastern portion of the range, the subdivision between northern and southern offshore *S. attenuata* found in the previous investigation was confirmed. In general, blocks to the west (including one encompassing part of the Hawaiian Islands) were more like the southern blocks than those of the northeast. Morphological patterns were similar to those found in a number of environmental variables, particularly water depth, solar insolation (January), sea surface temperature (January and July), surface salinity, and thermocline depth (winter and summer). Present management units are inconsistent with the pattern of cranial variation; spotted dolphins from west of latitude 120° W probably should not be pooled with those to the east, as they show closer affinity with the Southern Offshore unit. In addition, the boundary between the Northern and Southern units should probably be moved north to about latitude 5° N.

Polovina, J. J. 1993. The first ECOPATH. *In* V. Christensen, and D. Pauly (eds.), Trophic models of aquatic ecosystems, p. vii-viii. ICLARM Conf. Proc. 26, 390 p.

———, and B. B. Lau. 1994. Temporal and spatial distribution of catches of tiger sharks, *Galeocerdo cuvier*, in

the Pacific longline fishery around the Hawaiian Islands. Mar. Fish. Rev. 55(3):1-3.

Thirty-five tiger sharks, *Galeocerdo cuvier*, have been reported caught in pelagic longline gear from 25 to 265 nautical miles (nmi) off the Hawaiian Archipelago during December 1990-May 1993. Fifteen sharks were caught farther than 50 nmi offshore, indicating that tiger sharks do occur well offshore and removed from benthic topography. About 89 percent of the sharks were caught during October-March, while only 56 percent of the fishing effort occurred during that period.

Sakuma, K. M., H. A. Parker, S. Ralston, F. B. Schwing, D. M. Husby, and E. M. Armstrong. 1994. The physical oceanography off the central California coast during February-March and May-June, 1992: A summary of CTD data from pelagic young-of-the-year rockfish surveys. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-208, 169 p.

———. 1994. The physical oceanography off the central California coast during March and May-June, 1993: a summary of CTD data from pelagic young-of-the-year rockfish survey. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC-209, 174 p.

Salvadó, C. A. M. 1993. Population field theory with applications to tag analysis and fishery modeling: the empirical Green function. Can. J. Fish. Aquat. Sci. 50:2491-2512.

A theoretical framework is proposed for analyzing fish movement and modeling the associated dynamics using tagging data. When tagged fish are released in a small area compared with the domain of the fish population and over a short period compared with the time they take to disperse throughout their domain, the pattern of movement approximates a point-source solution of the underlying population dynamics. A method of point sources (Green functions) is invoked for representing the solution of the tagged and untagged fish field equations (partial differential equations) in terms of integral equations. As an approximate representation of a tagging experiment, the Green function is interpreted as the probability density of survival and movement from point to point in space-time. The Green functions are constructed empirically using one parameter, catchability, as the ratio of population density of tagged fish divided by the number of tagged fish released. The number of tagging experiments necessary to characterize the population is dictated by the dependence of catchability on space-time. The moments of the Green function are used to calculate model parameters and lead to the identification of a closed form expression for the transition probability densities of the model assumed.

Squires, D., M. Alauddin, and J. Kirkley. 1994. Individual transferable quota markets and investment decisions in the fixed gear sablefish industry. J. Environ. Econ. Manage. 27:185-204.

This paper presents an *ex ante* analysis of an individual transferable quota (ITQ) program imposed on one species in a multispecies fishery. Utilizing mathematical programming, pseudo data, and Tobit regression, market demand for quota and prospective gains in economic rent and efficiency gains from quota trade are assessed for the pot and longline sablefish fleet off the Pacific coast of the United States. Incentives for disinvestment and industry exit after quota exchange, implications for structure of the industry and ITQ market, and policy implications are examined.

Errata

In the Second Quarterly Report, 1994, the following publications from Marine Fisheries Review were listed incorrectly as published in 1994; they were published in 1993.

Boehlert, G. W. 1993. Fisheries and marine resources of Hawaii and the U.S.-associated Pacific Islands: an introduction. *In* Boehlert, G. W. (ed.), The fisheries of Hawaii and U.S.-associated Pacific Islands. Mar. Fish. Rev. 55(2):3-6.

———. 1993. The fisheries of Hawaii and U.S.-associated Pacific Islands (Preface). *In* Boehlert, G. W. (ed.), The fisheries of Hawaii and U.S.-associated Pacific Islands. Mar. Fish. Rev. 55(2):1-2.

Boggs, C. H., and R. Y. Ito. 1993. Hawaii's pelagic fisheries. *In* Boehlert, G. W. (ed.), The fisheries of Hawaii and U.S.-associated Pacific Islands. Mar. Fish. Rev. 55(2):69-82.

Boggs, C. H., and B. S. Kikkawa. 1993. The development and decline of Hawaii's skipjack tuna fishery. *In* Boehlert, G. W. (ed.), The fisheries of Hawaii and U.S.-associated Pacific Islands. Mar. Fish. Rev. 55(2):61-68.

Craig, P., B. Ponwith, F. Aitaoto, and D. C. Hamm. 1993. The commercial, subsistence, and recreational fisheries of American Samoa. *In* Boehlert, G. W. (ed.), The fisheries of Hawaii and U.S.-associated Pacific Islands. Mar. Fish. Rev. 55(2):109-116.

Grigg, R. W. 1993. Precious coral fisheries of Hawaii and the U.S. Pacific Islands. *In* Boehlert, G. W. (ed.), The fisheries of Hawaii and U.S.-associated Pacific Islands. Mar. Fish. Rev. 55(2):50-60.

Haight, W. R., D. R. Kobayashi, and K. E. Kawamoto. 1993. Biology and management of deepwater snappers of the Hawaiian Archipelago. *In* Boehlert, G. W. (ed.), The fisheries of Hawaii and U.S.-associated Pacific Islands. Mar. Fish. Rev. 55(2):20-27.

Hamm, D. C. 1993. The western Pacific fishery information network: a fisheries information system. *In* Boehlert, G. W. (ed.), The fisheries of Hawaii and

U.S.-associated Pacific Islands. Mar. Fish. Rev. 55(2):102-108.

Hensley, R. A., and T. S. Sherwood. 1993. An overview of Guam's inshore fisheries. *In* Boehlert, G. W. (ed.), The fisheries of Hawaii and U.S.-associated Pacific Islands. Mar. Fish. Rev. 55(2):129-138.

Myers, R. F. 1993. Guam's small-boat-based fisheries. *In* Boehlert, G. W. (ed.), The fisheries of Hawaii and U.S.-associated Pacific Islands. Mar. Fish. Rev. 55(2):117-128.

Nitta, E. T., and J. R. Henderson. 1993. A review of interactions between Hawaii's fisheries and protected species. *In* Boehlert, G. W. (ed.), The fisheries of Hawaii and U.S.-associated Pacific Islands. Mar. Fish. Rev. 55(2):83-92.

Polovina, J. J. 1993. The lobster and shrimp fisheries in Hawaii. *In* Boehlert, G. W. (ed.), The fisheries of Hawaii and U.S.-associated Pacific Islands. Mar. Fish. Rev. 55(2):28-33.

Pooley, S. G. 1993. Economics and Hawaii's marine fisheries. *In* Boehlert, G. W. (ed.), The fisheries of Hawaii and U.S.-associated Pacific Islands. Mar. Fish. Rev. 55(2):93-101.

———. 1993. Hawaii's marine fisheries: some history, long-term trends, and recent developments. *In* Boehlert, G. W. (ed.), The fisheries of Hawaii and U.S.-associated Pacific Islands. Mar. Fish. Rev. 55(2):7-19.

Smith, M. K. 1993. An ecological perspective on inshore fisheries in the main Hawaiian Islands. *In* Boehlert, George W. (ed.), The fisheries of Hawaii and U.S.-associated Pacific Islands. Mar. Fish. Rev. 55(2):34-49.

Approved by Science and Research Director, SWR

Barry, J. P., M. M. Yoklavich, G. M. Cailliet, D. A. Ambrose, and B. S. Antrim. Food habits, dietary overlap, trophic selectivity, and trophic spectra of the dominant fishes in Elkhorn Slough, California. For consideration for publication in Estuaries.

Boehlert, G. Larval dispersal and survival in tropical reef fishes. For consideration for publication in Tropical Reef Fisheries.

Demer, D. A., and L. V. Martin. Zooplankton target strength: Volumetric or areal dependence? For consideration for publication in Journal of the Acoustical Society of America.

Fiedler, P. C., and J. Barlow. Acoustic backscatter results from marine mammal surveys in the eastern Pacific (1988, 1992 and 1993). For consideration for publication in Fishery Bulletin, U.S.

Freese, S., J. Glock, and D. Squires. Direct allocation of resources in fisheries: a cost-benefit analysis of Pacific whiting. For consideration for publication in Center for Marine Law and Policy.

Gerrodette, T. The ability of IDCR cruises to detect changes in blue whale population size. For consideration for publication in Report of the International Whaling Commission.

———, H. Pérez-Cortés, L. Fleishcher, and B. Villa. Distribution of the vaquita, *Phocoena sinus*, based on sightings from systematic surveys. For consideration for publication in Report of the International Whaling Commission (Special Issue).

Laidig, T. E., P. B. Adams, C. H. Baxter, and J. L. Butler. Feeding on euphausiids by *Octopus rubescens*. For consideration for publication in California Fish and Game.

MacFarlane, R. B., and M. J. Bowers. Matrotrophic viviparity in the yellowtail rockfish *Sebastes flavidus*. For consideration for publication in Journal of Experimental Biology.

Moser, H. G., R. L. Charter, P. E. Smith, D. A. Ambrose, S. R. Charter, C. A. Meyer, E. M. Sandknop, and W. Watson. Distributional atlas of fish larvae in the California Current region: taxa with less than 1000 total larvae, 1951 through 1984. For consideration for publication in California Cooperative Oceanic Fisheries Investigation.

Newcomer, M. W., T. A. Jefferson, and R. L. Brownell, Jr. *Lissodelphis peronii* (Lacèpède, 1804) southern right whale dolphin. For consideration for publication in American Society of Mammalogy.

Okechi, J. K., and J. J. Polovina. The evaluation of artificial shelter, "casitas," in artisanal spiny lobster fishery at Gazi Bay, Kenya. For consideration for publication in South Africa Journal of Marine Science.

Parrish, R. H., and D. L. Mallicoate. Variation in the condition factors of California pelagic fishes and associated environmental factors. For consideration for publication in Fisheries Oceanography.

Polovina, J. J. Artificial reefs: a little habitat, lots of controversy. For consideration for publication in Natural History Magazine.

———, G. T. Mitchum, and G. T. Evans. Decadal and basin-scale variation in mixed layer depth and the impact on biological production in the Central and North Pacific, 1960-88. For consideration for publication in Deep-Sea Research.

Ralston, S., and D. F. Howard. On the development of year-class strength and cohort variability in juvenile rockfishes. For consideration for publication in Fishery Bulletin, U.S.

Sakuma, K. M., and T. E. Laidig. Description of larval and pelagic juvenile *Sebastes goodei* with an examination of larval growth. For consideration for publication in Fishery Bulletin, U.S.

Steiner, M. T., N. Garfield, and F. B. Schwing. Net nontidal transport estimates for the Gulf of the Farallones,

1991-1992. For consideration for publication in abstract for AGU 1994 Fall Meeting.

Administrative Reports

Administrative Reports are strictly for internal use only and are not to be cited or treated as publications.

Honolulu

DeMartini, E. E., F. A. Parrish, and J. D. Parrish. 1994. Temporal comparisons of reef fish populations at Midway Atoll, Northwestern Hawaiian Islands. SWFSC Admin. Rep., Honolulu, H-94-05, 56 p.

Dollar, R. A. 1994. Annual report of the 1993 western Pacific longline fishery. SWFSC Admin. Rep., Honolulu, H-94-06, 38 p.

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